Spectrum Bridge response to PN DA-09-2479
Proposals for Designated TV Band Database Manager
ET Docket No. 04-186

January 4, 2010

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Introduction

Spectrum Bridge, Inc. ("Spectrum Bridge", "SBI") hereby responds to the Commission's request for proposal in the above-referenced docket ("*TV Band Device Database Managers*")[1].

Spectrum Bridge was established in 2007 with the goal of identifying and implementing automated methods to facilitate access to spectrum for service providers, private users, equipment manufacturers, and systems integrators through secondary market transactions[2] with our innovative SpecEx® marketplace. The FCC recognized the challenges and opportunities of secondary markets and the role being played by Spectrum Bridge in the Innovations Notice of Inquiry[3]. Spectrum Bridge also developed and sells a suite of spectrum management tools collectively known as SmartWaves. Providing a White Spaces Database is a natural offshoot of Spectrum Bridges' core intellectual property and business model. SBI demonstrated an experimental prototype White Spaces Database to the FCC in January 2009 and followed up with a prototype White Spaces network solution in June 2009[4]. As a result SBI obtained an FCC experimental License and deployed what is believed to be the world's first White Spaces network in Claudville, Virginia. SBI is currently in the process of deploying a white spaces network in Wilmington, North Carolina and has plans to deploy White Spaces networks in Lake Mary, Florida and West Virginia, introducing solutions for telemedicine, smart grid and smart cities. In addition SBI has been actively demonstrating the capability and promise of TV White Spaces to several international regulatory bodies. As a result of the Claudville deployment, SBI has received requests from dozens of communities asking us to solve their lack of broadband access using White Spaces solutions. In many cases these communities have described how they have tried for years, without success, to provide broadband access.

Spectrum Bridge believes while it is crucial that the FCC specify what the database and TV White Spaces devices (WSDs) must do; it should not specify the underlying architecture or technology used to provide the solution. TV White Spaces not only offer the opportunity to provide much needed access to spectrum but also introduce a new concept in how spectrum can be allocated and accessed automatically. This concept is so new that the technology for managing access, merging licensed and unlicensed spectrum, adding secondary market spectrum and newly available spectrum must rapidly evolve as solutions are implemented. It is also true that the interaction between cognitive radio networks and the database will rapidly evolve as these technologies mature. In such a rapidly changing environment, the best way for the Commission to encourage innovation is to allow each provider to choose the technology which best suits its business objectives.

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1 *Office of Engineering and Technology Invites Proposals from Entities Seeking to be Designated TV Band Device Database Managers*, ET Docket Nos04-186

2 *See* Spectrum Bridge Home Page, http://www.spectrumbridge.com

3 Fostering Innovation and Investment in the Wireless Communications Market, GN Docket No. 09-157, August 27, 2009

4 200964519952, June 4, 2009, Docket: 04-186

This response is partitioned into five sections to reflect the five major questions asked by the FCC in the Public Notice. Additional information is provided in appendices that follow.

Spectrum Bridge intends to provide a complete White Spaces Database Solution. Each of the questions asked by the FCC in the Public Notice is answered in detail. SBI believes that the proposed solution exceeds all the requirements, as currently defined by the FCC. In addition SBI remains committed to evolve and adapt to the changes to requirements and the demands of the technology and market place. SBI is also committed to an open and competitive marketplace as the most efficient and effective method of delivering Whites Spaces capability to the American public. Therefore SBI will continue to work with any and all interested parties to create open and sustainable functions and protocols, specifically to:

- Ensure a healthy and competitive eco-system of multiple White Spaces databases, to promote reliability, innovation and competition in basic and enhanced database services
- Promote overall architectures that could be applied to international markets.
- Allow flexibility in the overall system architecture to avoid technology choke points, and allow future adaptability
- Help ensure that incumbents are protected in a manner consistent with the TV White Spaces operating rules
- Ensure the privacy of registered protected entity and TV band device user data (i.e., identity and contact information)
- Create a database with multiple layers of protection which only allow authorized parties to enter or amend data

SBI will be happy to provide further detail on any aspect of this proposal should the Commission require it. For more information please contact:

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Question 1

(*The entity must demonstrate that it possesses sufficient technical expertise to administer a TV band database. It must demonstrate that it has a viable business plan to operate a database for the five-year term set forth in Section 15.715(g) of the rules. To the extent that the proponent will rely on fees from registrations or queries, the proposal should describe the fee collection process.)*

Technical Competence

Spectrum Bridge is a well capitalized private company with substantial support for its plans from its Investor team[5]. The management team has extensive experience in wireless telecommunications and database solutions. They created the first cellular billing clearing house[6], created the first online exchange for secondary market spectrum[7] and had pioneering leadership roles in multiple Telecommunications technologies from soft switches[8] to ad-hoc networks[9].

SBI first demonstrated a Beta version of a White Space Database to the FCC in January 2009, demonstrated a complete online White Spaces solution in June[10], and subsequently deployed what is believed to be the world's first white spaces network solution in Claudville, Virginia in September 2009. SBI is currently in the process of planning and deploying four additional White Spaces networks, including locations in Wilmington, North Carolina, and Lake Mary, Florida, that are controlled and directed by SBI's existing proprietary White Spaces database. These deployments are being conducted in partnership with industry leaders, content providers, members of the White Spaces Database Group and White Spaces Radio Developers. SBI is also participating with the development of White Spaces opportunities with several international regulatory bodies.

SBI has the capability to provide secure and scalable Internet based services for managing whitespaces as demonstrated by the operation of the online spectrum market place. This application employs industry standard techniques and protocols to provide a high degree of authentication and security to support online financial transactions related to the buying, selling and leasing of secondary market spectrum.

Business Model

It is anticipated that the market for TV White Space Devices (WSDs) and related services will be a multi-billion dollar opportunity[11] with hundreds of millions of devices shipped by 2014 (ABI Research, In-Stat and SBI estimates). It is envisioned that the TV

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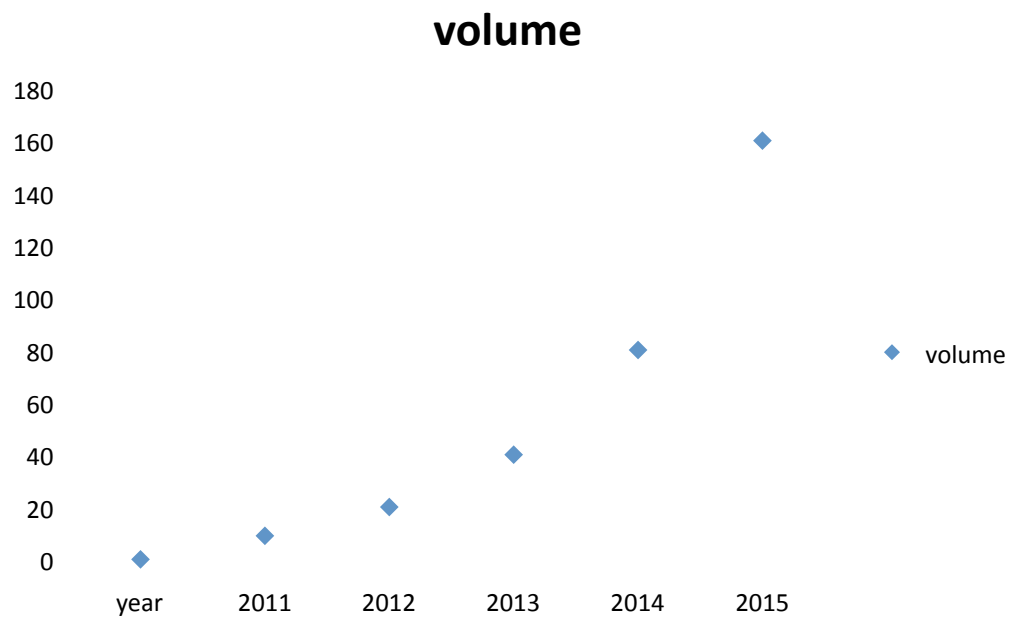
5 Telecom Development Fund, True Ventures Espirito Santo Ventures and Milcom V.P.
6 Cincinnati Bell Information Systems (CBIS), Now Convergys
7 www.specex.com
8 Excel Switching Systems
7 MeshNetworks Inc.
10 www.showmywhitespace.com
11 www.ingeniousmedia.co.uk/websitefiles/Value_of_unlicensed_-_website_-_FINAL.pdf

White Spaces market will satisfy many segments of the domestic United States telecommunications market where spectrum constraints exist, in urban and rural America. It is envisioned that because of the economical cost and availability of TV White Spaces, they can be used to provide a myriad of last and middle mile wireless broadband access solutions. These prospective deployments will not be economically viable if not for the availability of this unlicensed spectrum band with excellent propagation characteristics. That said, a key driver in the potential success of this nascent segment of the telecommunications market will be the timely designation of database service providers and the completion of the rule making. For the purpose of this response it has been assumed that these events will take place before the end of 2Q2010.



SBI Projected US shipments of White Spaces Devices (in millions of units)

The projected rate of adoption for White Spaces Device unit shipments, shown above, is based on the WiFi/802.11 technology[12] historical unit shipments for 2000-2005. As expressed in the chart, the adoption rate is expected to be minimal in 2010 and 2011, while rapidly escalating in 2011 after large-scale marketing and manufacturing takes place. The Spectrum Bridge business plan is designed to accommodate this trend and is conservatively developed around a competitive environment where Spectrum Bridge serves a small percentage of the total addressable market during the course of the initial five-year term.

The Spectrum Bridge revenue model is comprised of two primary fee components; a per-unit device fee and value added service fees. The first is a simple, per device fee that is paid by the device manufacturer. This one-time fee is kept as low as possible to encourage the adoption of White Spaces Devices. Value added service fees would be paid by those utilizing these services to better optimize the experience and

[12] Wifi shipment analysis by ABI Research and In-Stat.

functionality of the device and network. These additional fees contribute to the basic support services and therefore contribute to maintaining low costs for the basic per unit device fee. The business model, as described below, is focused on the US market, however, SBI ultimately expects to be offering White Spaces services internationally as White Spaces rules are authorized by regulators.

Device Fees

The payment of these one-time, per unit fees will be based on business relationships with the device and/or radio manufacturer. The implementation of this plan will also allow for the devices to be authenticated. Device fees will be payable the first time that a device registers with the database. Spectrum Bridge will then invoice the manufacturer based on the registration information (FCC ID and serial number). It is also anticipated that other entities such as Internet Service Providers and/or System Integrators would pay this one-time fee if they deploy TV White Spaces networks with specialized radios not available through existing high-volume/mass-market radio manufacturing channels. At this time, major manufacturers like Dell and Motorola (with whom Spectrum Bridge is in discussions), have expressed a clear preference for this type of single, one-time payment solution rather than any kind of recurring fee structure. These manufacturers also prefer that consumer and small business end-users not directly participate in the registration process and hence creating a plug and play experience at activation of the device.

Value Added Service Fees

It is expected that the value added services, that can be provided above and beyond the basic database access capabilities required by the Commission, will drive additional revenue opportunities. Those wishing to utilize these services will enter into a direct business relationship with Spectrum Bridge or designated channel partner and will include a wide range of services from the simplest services to the most complex.

Question 2

(*The entity must describe in detail the scope of the database functions that it intends to perform, such as managing a data repository, performing calculations to determine available channels, and/or registering fixed unlicensed devices and licensed services not listed in the Commission's databases, or how it will have functions performed in a secure and reliable manner by another entity. The entity must also describe how data will be synchronized between multiple databases if multiple databases are authorized and how quickly this synchronization of data will be accomplished*)

Technical Solution

Spectrum Bridge is proposing to perform all the functions required by the Commission of a TV White Space Database (WSDB) manager. A working beta version of the solution is available at www.showmywhitespace.com.

The solution architecture was developed based on the requirements for the TV Bands Database in FCC 08-260 and on discussions within various White Spaces forums and industry working groups (i.e. IEEE 802.22). The architecture is specifically designed to accommodate the regulatory requirements established by the FCC. Furthermore, SBI expects that the technology and market place will rapidly evolve once White Spaces devices are available. SBI will adapt the architecture as required to maintain compliance with any updates or changes to the rules that arise in the future. The specific functions are outlined below.

Managing a data repository

The proposed solution utilizes all information regarding FCC-registered protected entities (e.g., TV Stations, PLMR/CMR, and BAS services, from the FCC's CDBS and ULS databases) and their associated exclusion zones and stores them in a GIS encoded database (or data repository) along with data regarding registered protected entities, such as wireless microphones and receive sites. Typical TV station information includes transmitter location, channel number, call sign, ERP, antenna pattern (and antenna HAAT), These elements are detailed in Appendix 1.

Performing Calculations/determining available channels

The solution will execute any calculation or use any contour specified by the Commission to determine the availability of white space in any given location for each device type (WSD). The solution, which utilizes FCC supplied data, is described in Appendix 1.

Registering fixed unlicensed devices and licensed services not listed in the Commission's database

The solution provides the capability to register unlicensed devices not listed in the Commission's databases. Some examples of registered licensed services include authorized wireless microphones, cable headend and TV translator receive sites, and

temporary BAS links. The registration API is described in Appendix 3, and the protection contours that are created are described in Appendix 1 and will be modified as required by the Commission.

Synchronizing data between multiple databases

The proposed solution also provides interfaces and protocols for synchronization between databases as described below.

Because each WSDB will collect unique data from white space users, microphone users, BAS link, cable headend and TV translator site registrants, it is necessary to facilitate secure and efficient data sharing between WSDBs and the FCC. SBI will provide client access credentials to trusted entities (WSDBs authorized by the FCC). The SBI Solution will serve as a root certificate authority with respect to other trusted WSDBs and use a centralized Public Key Infrastructure (PKI). A root certificate can be shared with all trusted WSDBs for further authentication. The SBI solution can also provides certificates to each individual WSDB. This aids individual WSDBs in establishing a SSH shell with SBI and exchange data. In addition, industry standard web services such as the Simple Object Access Protocol (SOAP) may be used to exchange protected entity information among WSDBs in near real-time.

This interface is designed to facilitate the acquisition and sharing of Registered Protected Entity (wireless microphones, BAS links, TV translator) information between authorized WSDBs, data repositories and regulatory entities. The same format and protocol is proposed for the exchange of data with all entities, regardless of function and could be easily modified to support other data types.

Synchronization timing

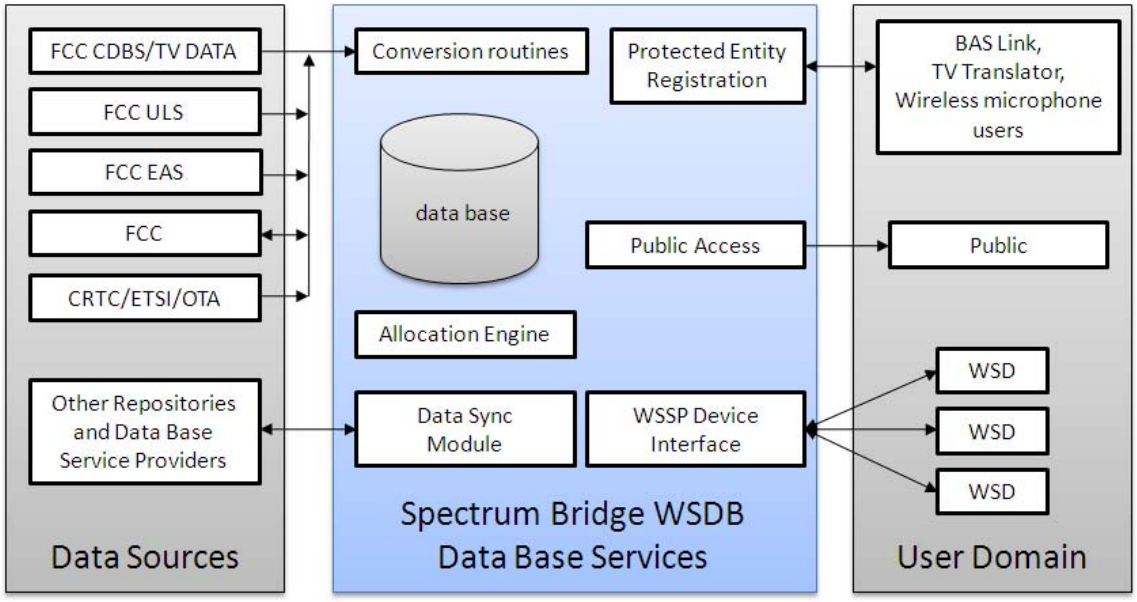
Because FCC TV contour, fixed protected entity data and ULS data is readily available from the FCC and is relatively slowly changing, no need currently exists to share this data among discrete entities on a real time basis. It is expected that data entry size will range from several hundred bytes (wireless microphones) to several kilobytes for protected entities such as TV translators, BAS links and cable headends. By all measures, the data associated with registered entries is a small percentage of the overall data. Estimated data storage requirements for all registered entity data, is not expected to exceed 500 MB (~50 MB compressed). In this solution a simple secure file transfer (FTP over a SSH shell) protocol will be used. All data will be posted as it is updated (near real time). The SBI solution polls other WSDBs to check for updates. The database can complete this process, in several minutes.

Question 3

(*The entity must provide diagrams showing the architecture of the database system and a detailed description of how each function operates and how each function interacts with the other functions)*

System Architecture

The Architecture described below and in subsequent sections is intended to provide full compliance with the rules as defined to date by the FCC in the Report and Order. The architecture will be updated to support any change in the definition of those rules. The basic components of the solution are as depicted, and described below followed by a description of the various interfaces to the solution.



Conversion Routines

This Function accumulates data from FCC sources described in "Data Sources" below and performs the calculations required to generate the contours stored in the database. As this data is publicly available from sources such as the ULS, it is not included in the data that would be synchronized with other WSDBs.

Data Sources

The information necessary to manage and allocate the use of white spaces and insure compliance with FCC rules obtained from the following primary data sources:

FCC TV contour files
Digital television stations,
Class A (television stations digital and analog),
Low Power television stations, (LPTV),

Translator and booster stations

FCC Consolidated Database System
Additional TV license parameters (e.g., transmitter location, ERP, antenna pattern, HAAT, etc.)

FCC ULS database
Broadcast Auxiliary Stations
Part 90 (T-band) allocations

FCC EAS (equipment authorization) data base
FCC Authorized WSDs

47 CFR Part 15 Subpart H – Television Band Devices
International border areas, other protected areas

Protected Entity Registration

This function provides the access for designated entities to register for protection. Devices such as cable headends and translators fit this definition. Once input, this function creates an exclusion zone that is stored in the database. Examples of each protected entity are shown in appendix 1. This data is synchronized with other WSDBs. User supplied protected entities:

Microphones
Other BAS links
Cable headends
TV translators

Public Access

This function is a simple Web based interface that lets the public view the availability of white space for a location that they input (see www.showmywhitespace.com). This interface does not and will not display private data of any kind.

WSDB Device Interface

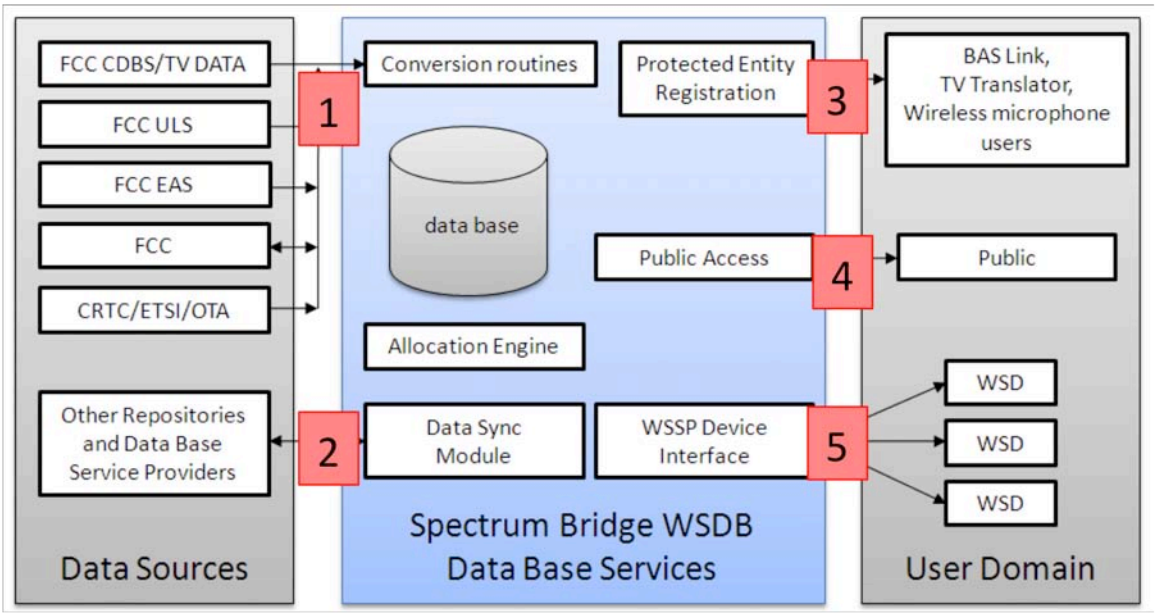
This function provides the electronic Internet based interface for WSDs to register and query the database for available TV channel allocations. The protocols are described in detail in section 5. The channel allocation methodology is described in Appendix 2.

Data Sync Module

This function collects and provides information about protected entities and makes it available to other WSDBs and/or the FCC. The Data Sync Module that can accommodate a peer solution to other WSDBs (many to many) as well as a solution based on a centralized synchronization function (many to one).

Interfaces

Several interfaces are required for the WSDB to manage and interface with various elements of the white space ecosystem. These elements are summarized below:



FCC interface [1]

- Provides FCC-registered protected entity information, as described above. Supports directives to WSDBs to return "no channel available" response to a specific WSD or WSDs of a specific model or to de-register a Registered WSD or WSDs of a specific model

Data Sync Module [2]

- Used to acquire and distribute (share) protected entity data acquired or needed by SBI
- Enrolls with to facilitate data sharing
- Accepts enrollment of other WSDBs and data repositories
- Provides WSD Datasets

Protected Entity Registration [3]

- Interface for registration or update of protected entities (BAS links, cable headends, wireless microphones and TV translators) not provisioned within existing regulatory databases
- Support de-registration of protected entity data

Public Access Interface [4]

- Web based interface for general information or queries
- www.ShowMyWhiteSpace.com is the current implementation

- Verify registration data
- Provide general TV white space information
- Customer support
- File disputes

WSDB to WSD device Interface [5]

- Internet accessible interface used by WSDs to request white space channels
- Facilitate WSD registrations
- Process WSD queries for a list of available channels
- Returns available channel data to device

Server Architecture and Maintenance

Spectrum Bridge follows industry best practices to ensure complete continuity of operations in the face of any type of disaster affecting physical plant, technical infrastructure and human operations. The WSDB Data Center is modeled on the Data Center that supports the SpecEx and SmartWaves products and services. As SpecEx is a system that accepts electronic payments this solution is designed to be compliant with the Visa PCI and SAS-70 Type II audit standards. This Data Center architecture is designed to scale with the increase in deployment of White Spaces devices. The Data Center meets the following requirements and employs these elements:

- Remote offsite secure facility with access control, 24 x 7 x 365
- Constant Power (Redundant Power Sources) Distributed UPS and Facility level generators
- Redundant Fiber Connectivity - redundant Gigabit Ethernet uplinks, redundant core routers
- Controlled Environment (Environmental Monitoring) - humidity, temperature and water detection
- Fire Prevention & Suppression
- 24 x 7 x 365 Monitoring and on site Operational Support
- SBI dedicated servers - Operating System: Windows 2003, or Red Hat Linux 4.0
- Managed Security - Secure Web-based Communication Portal, Firewall Solutions, VPN Capable, Intrusion Detection & Prevention
- Load balancing to guard against bottlenecks and efficiently distribute traffic across the servers
- Hot standby - multiple application server arrays to keep the services running even if a server fails
- Automated Data Backup & Restore - Duplicate/independent database storage units with database replication

Based on the current implementation of www.showmywhitespace.com the initial Database requirement, for geo-location contour data, is estimated at 500 Gigabytes.

This number will remain relatively stable until the pool of White Spaces spectrum is augmented in the future. The additional data held related to the service is currently less than 100 Gigabytes. Over time the registration data will grow as more devices are deployed. However, this is estimated to be less than 20 Gigabytes per 100 million devices.

Data Protection and Privacy

Spectrum Bridge takes the protection and privacy of data in the database very seriously including a commitment to maintaining confidentiality of non-public information related to protected entities and device registrations. SBI will not disclose or use any information for any purpose other than the processing of White Spaces transactions and support of the WSDB. Spectrum Bridge does intend to make channel availability information publically available in the simple form of a channel being available or not.

Question 4

(*If the entity will not be performing all database functions, it must provide information on the entities operating other functions and the business relationship between itself and these other entities. In particular, it must address how the Commission can ensure that all of the requirements for TV band database administrators in Section 15.715 are satisfied when database functions are divided among multiple entities, including a description of how data will be transferred among these various related entities and other databases if multiple databases are authorized and the expected schedule of such data transfers (i.e., real-time, once an hour, etc.).)*

Spectrum Bridge is proposing to provide all the functions and services required by the FCC in support of White Spaces operations, including the core database, channel calculations, interfaces to WSDs and the FCC, as well as support for registered protected entities.

SBI will provide interfaces to support data synchronization as described in the previous sections. The proposed design is flexible and will accommodate the partitioning of functions into several entities and has the capability to exchange data on a near real time basis. The interfaces and APIs proposed are to be open and flexible to accommodate adaptations required by the market place.

Question 5

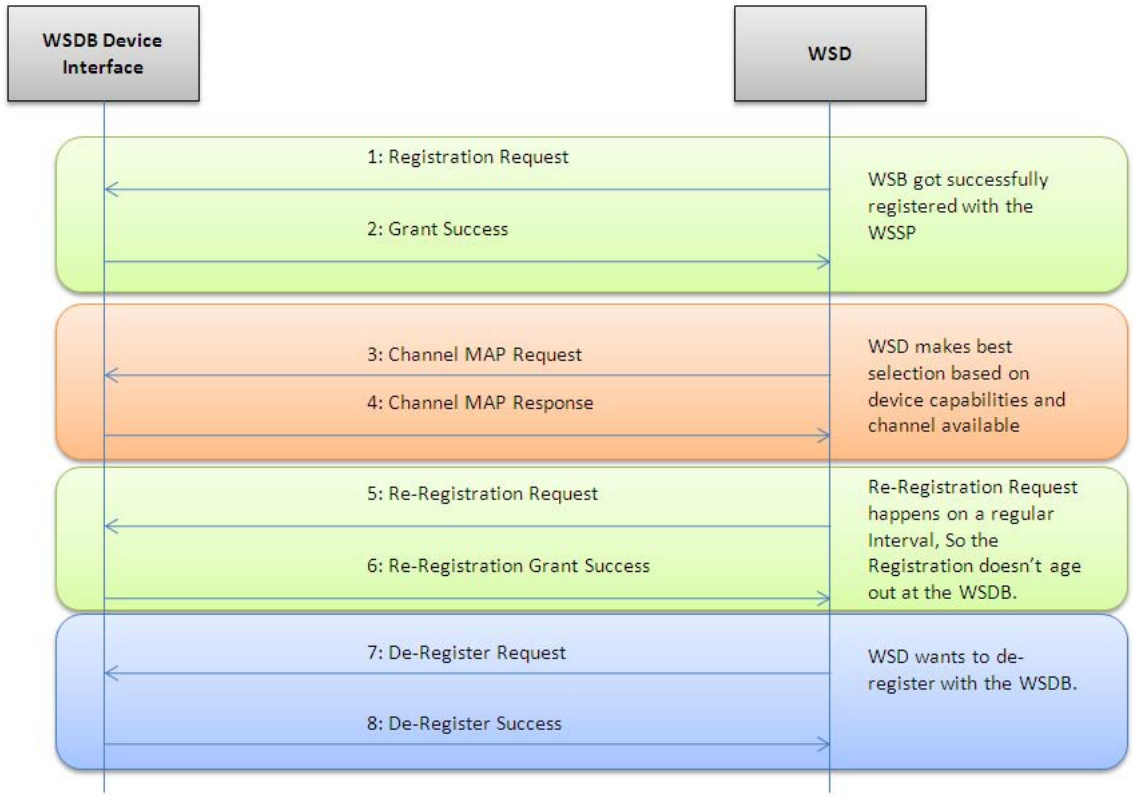
(*The entity must describe the methods (e.g., interfaces, protocols) that will be used by TV band devices to communicate with the database and the procedures, if any, that it plans to use to verify that a device can properly communicate with the database. It must include a description of the security methods that will be used to ensure that unauthorized parties can not access or alter the database or otherwise corrupt the operation of the database system in performing its intended functions. In addition, the entity should describe whether and how security methods will be used to verify that Mode I personal/portable devices that rely on another device for their geographic location information have received equipment authorization*)

Database to TVBD Protocols

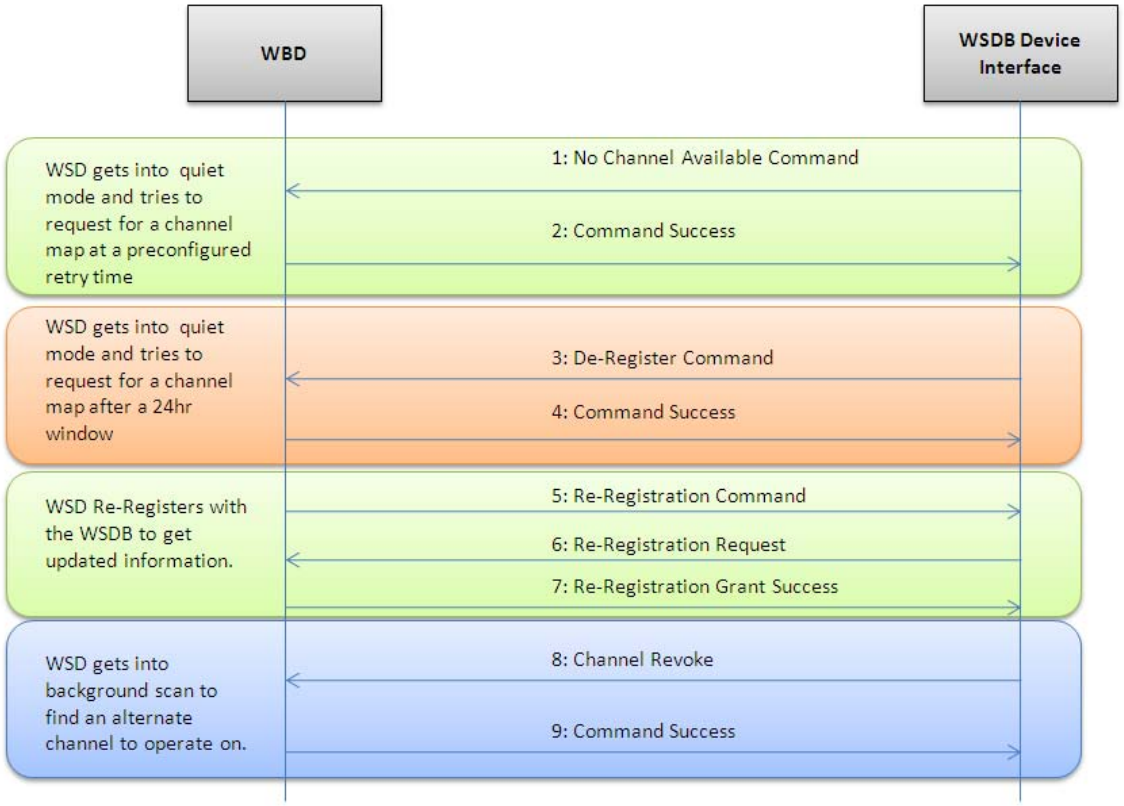
The protocols and APIs defined in this solution are intended to be open and accessible to all devices. All device interfaces for required database access are relatively simple and straightforward in nature. The possibility exists that several discrete interfaces may be required due to technical or market reasons. SBI will identify and support those interfaces as required.

The registration process will be supported through pre-existing relationships, which will be negotiated between Device Manufacturers and SBI. This relationship will define specific access terms. An OEM will acquire security credentials from SBI before devices are deployed in the form of a virtual client certificate. The same certificate can be shared among multiple devices manufactured by the same OEM. Subsequently, a TVBD will be able to authenticate the Database and the Database will be able to verify the device. Further detail is described in the security section below.

Communication between WSD and WSDB



Communication by WSDB to WSD



Database Security

Security is primarily focused on the interface between the WSD and the Database. The objective is to ensure that the WSDs obtain accurate channel information from an authorized source and will not get spoofed with invalid information from an unauthorized source. Compliance is ensured by requiring all entities to be authenticated using industry standard protocols and procedures. All communication between the database and WSD will use standard http protected by TLS over TCP/IP. TLS will be used to authenticate the WSDB provider's identity.

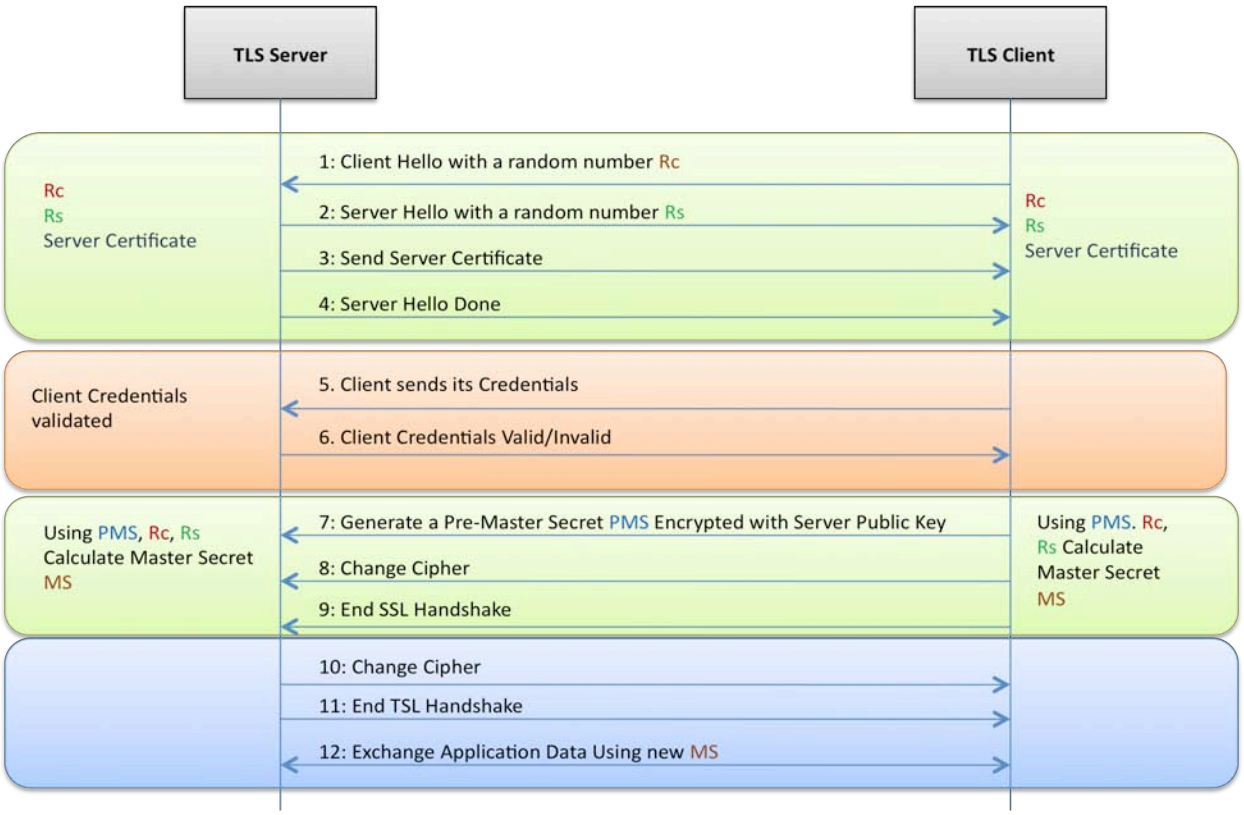
Other security issues are related to the access to the Database by protected entities, these issues are described in Appendix 3.

Data Base Access via WSDs

Fixed Devices

WSDs hold the certificate for the authorized WSDBs they communicate to validate the authenticity of the WSDB. These devices do not hold any client certificates. They will utilize a shared secret obtained from WSDBs they communicate with for communication at the time of enrollment. This shared secret can be a User-ID/Password authentication using an authentication server. The WSDB acts as a TLS authenticated server and the WSDs act like TLS Clients The following diagram depicts the message flow between the TLS Client and TLS Server. At the time of authentication, client User-Id/Password credentials must be verified by the WSDB (Authenticator) and the WSDB certificate has to be validated by the WSD (TLS Client). Once the Cipher is established, all payloads exchanged between the TLS Server and TLS Client are encrypted at the source and validated at the destination. There is also an Authenticator resident to authenticate Mode I WSDs to authentication server (See Mode I security association for message flow).

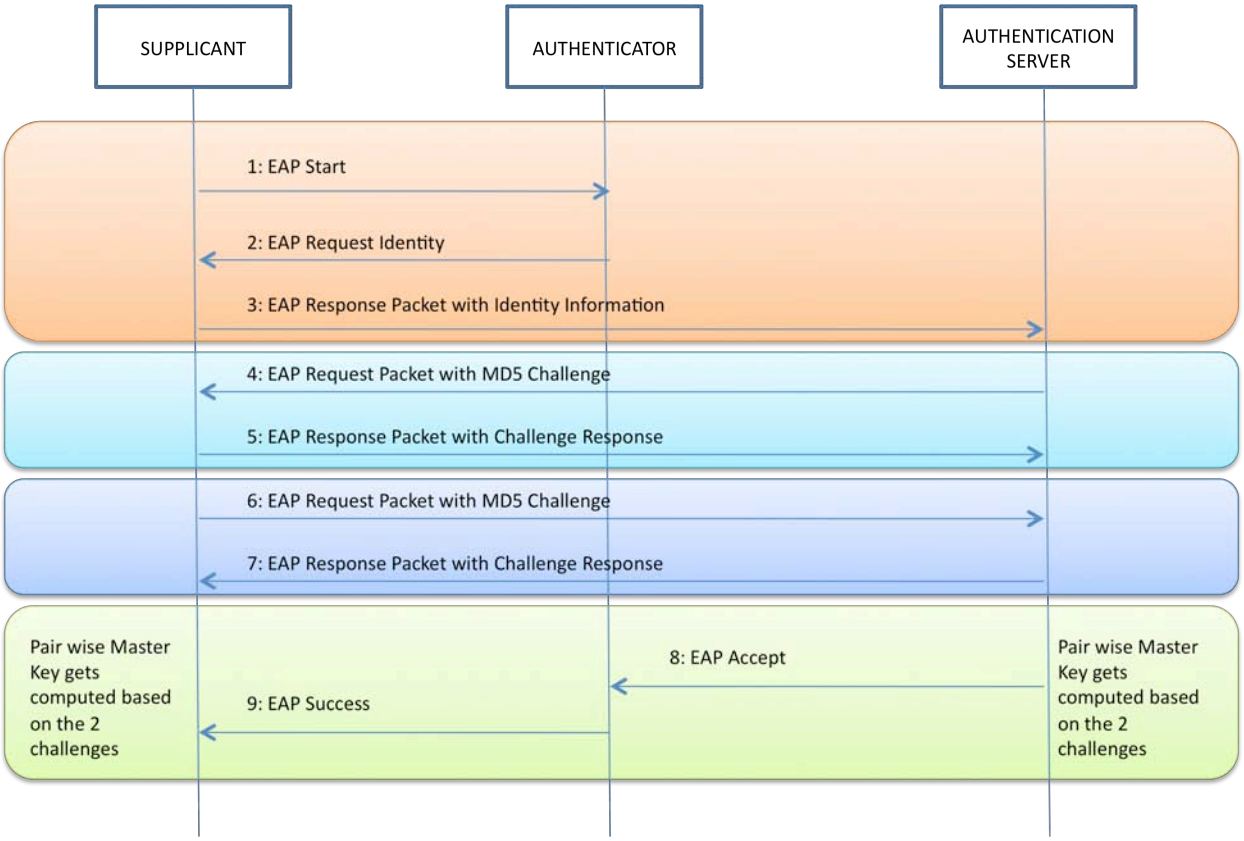
The WSDB emulates the functionality of the TLS Server. TLS Client functionality is sufficient for communication from the WSD. The message flow is as follows.



Portable Mode 1 (Client Devices for Fixed and Mode 2 Devices, No GPS)

Under the current unlicensed TV-band device operating rules, Mode I devices are not required to send their FCC ID and serial number to the database. However, if Mode I devices were required to send their identifying information to the database (through the Master device), they could be authenticated using the shared secret methods described above. This would allow a no-channels available messages to be sent to such devices.

Security typically occurs in the unlicensed system between the Mode I devices and the associated Fixed or Mode 2 (Master) devices. These secure associations are going to be at the layer 2 authentication/integrity checking protocols involving supplicant, authenticator, and an authentication server using 802.1x types messaging to an authenticating server like Radius Server. This authentication server has to be resident at Database Service Provider but the authenticator runs at the associated device. Once a secure association is established further communications are all secured using Pairwise Master Key (PMK).



Portable Mode 2 (GPS enabled)

Security behavior is the same as for fixed mode devices.

Data Sync Security

Because each WSDB will collect unique data from white space users, authorized microphone users, and BAS link, cable headend and TV translator site registrants, it is necessary to facilitate secure and efficient data sharing between WSDBs and the FCC. SBI can provide client access credentials to trusted entities (WSDBs authorized by the FCC). The SBI white spaces data sync module may also serve as a root certificate authority with respect to other trusted WSDBs and use a centralized Public Key Infrastructure (PKI). A root certificate can be shared with all trusted WSDBs for further authentication. This helps individual WSDBs to establish a SSH shell with SBI and exchange data.

Exception Handling/News Event Constructs

SBI has demonstrated a more reactive version of a database manager to the FCC[13]. As shown it was described as an "Exception Handler", in filings with the FCC others have described a similar concept as a "News Event" to describe a temporary and immediate need for spectrum to be cleared. The example demonstrated by SBI permitted an authorized entity to define an exclusion zone (1 km radius in the example) around a specific location for a period of time (0.5-24 hours). As demonstrated, the database identified all WSDs that fell within the shadow of the exclusion zone and pushed a "channel revoke" message to these devices, forcing them to give up their existing channel assignment and request a new assignment that, by implication, does not include the "Exception" channel. The database solution proposed herein by SBI has all the capability to support an exception handler and push such an event out to a WSD. Such a solution would require the synchronization refresh rate to be less than the minimum time permitted for an exclusion zone or news event to be enacted. The demonstration to the FCC showed an implementation that could free up a channel in less than 10 minutes and we expect to meet this criterion under real operating conditions

[13] 200964519952, June 4, 2009, Docket: 04-186

Appendix 1: Protected Entity and Exclusion zone Data Elements

This appendix describes the various protected entities and exclusion zones and how they are implemented in the database.

Protected contours for TV stations can be calculated using information about TV transmitter parameters obtained from CDBS. Specifically, this information includes TV transmitter location, channel number, call-sign, ERP, horizontal antenna pattern, and antenna HAAT (at a minimum). The appropriate FCC R-6602 F-curves (for the desired band and TV service) can then be utilized to compute TV protected contours. This method is described in the current TVWS operating rules (Section 15.712).

Alternatively, the WSDBs could utilize the FCC's pre-computed contour information for TV services, as described below. The further application of the minimum required separation distances is required in either case, depending on the type of WSD deployment (personal/portable WSD, or fixed WSD antenna height).

Television Stations – Digital, Class A (digital and analog), Low Power (LPTV), Translator and Booster

Today Contour sets for full service TV stations and Class A TV, low power TV, TV translator and TV booster stations can be obtained directly from the FCC's published contour data. Since the FCC publishes contours generally accepted by the broadcast industry, a practical approach would be to simply use the contour data published by the FCC:

http://www.fcc.gov/ftp/Bureaus/MB/Databases/tv_service_contour_data/

Spectrum Bridge has developed algorithms to derive contours directly from data obtained from the FCC's CDBS TV query database:

http://www.fcc.gov/mb/video/tvq.html/

These algorithms include propagation models described by R-6602 and employ the implementation described in FCC/OCE Report RS76-01. Note that the use of radial HAAT values can also be supported.

Ultimately the solution will utilize the method and algorithms preferred or required by the FCC.

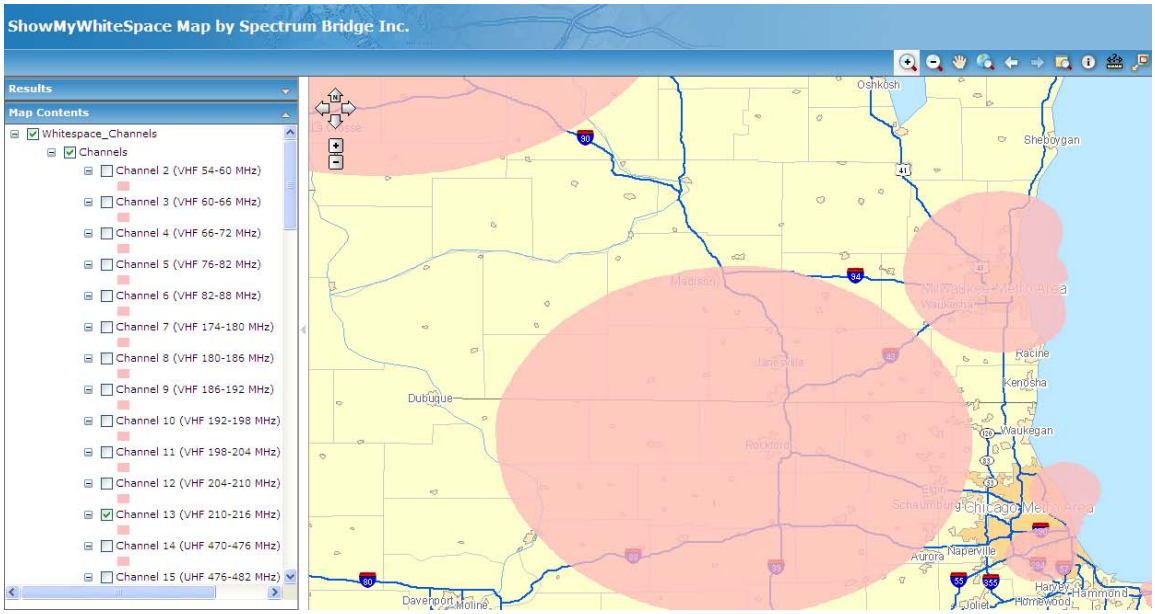
The signal levels that define a television station's protected contour vary, depending on the type of station and band: low VHF band (channels 2-6), the high VHF band (channels 7-13) and the UHF band (channels 14-51).

Type of station	Protected contour[219]		
	Channel	Contour (dBu)	Propagation curve
Analog TV	Low VHF (2-6)	47	F(50,50)
	High VHF (7-13)	56	F(50,50)
	UHF (14-69)	64	F(50,50)
Analog Class A, LPTV, translator and booster	Low VHF (2-6)	62	F(50,50)
	High VHF (7-13)	68	F(50,50)
	UHF (14-69)	74	F(50,50)
Digital TV	Low VHF (2-6)	28	F(50,90)
	High VHF (7-13)	36	F(50,90)
	UHF (14-51)	41	F(50,90)
Digital Class A	Low VHF (2-6)	43	F(50,90)
	High VHF (7-13)	48	F(50,90)
	UHF (14-51)	51	F(50,90)

Five (5) additional sets of contours are derived from the FCC contour set by adding the required keep-out zones below. Minimum required separation distances are added in a direction perpendicular to the tangent line of a contour. This TV contour set is then used in calculating white space availability as a function of the antenna height (of the WSD) and relative channel position. SBI anticipates no issues supporting multiple additional classes of unlicensed device parameters (e.g., additional antenna height categories for fixed WSDs).

Antenna Height of Unlicensed Device	Required Separation (kilometers) From Digital or Analog TV (Full Service or Low Power) Protected Contour	
	Co-channel	Adjacent Channel
Less than 3 meters	6.0 km	0.1 km
3 – Less than 10 meters	8.0 km	0.1 km
10 – 30 meters	14.4 km	0.74 km

A www.showmywhitespace.com screenshot of Channel 13 availability in the greater Chicago area.



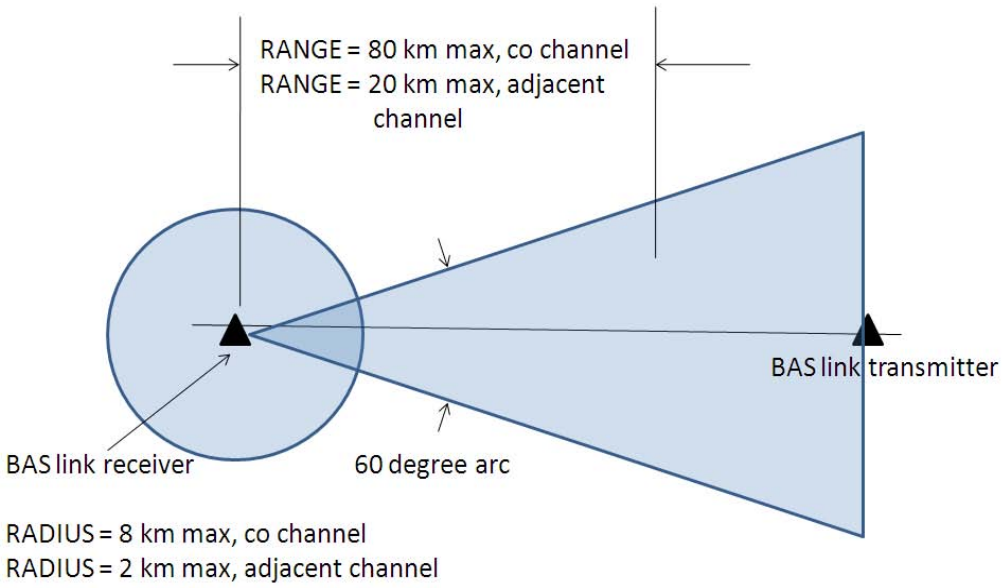
Broadcast Auxiliary Service (BAS)

Operating parameters for fixed Broadcast Auxiliary Services (BAS) links are obtained from the FCC's Universal Licensing System (ULS). The ULS currently shows approximately 220 authorized fixed broadcast auxiliary links in channels 14-51 that are active. SBI will allow entities to register links not listed in the FCC ULS database so that they may receive the same protection as permanent (FCC-registered) fixed BAS links. Contours are generated in GIS format in accordance with the diagram below and are used in the calculation of available white space.

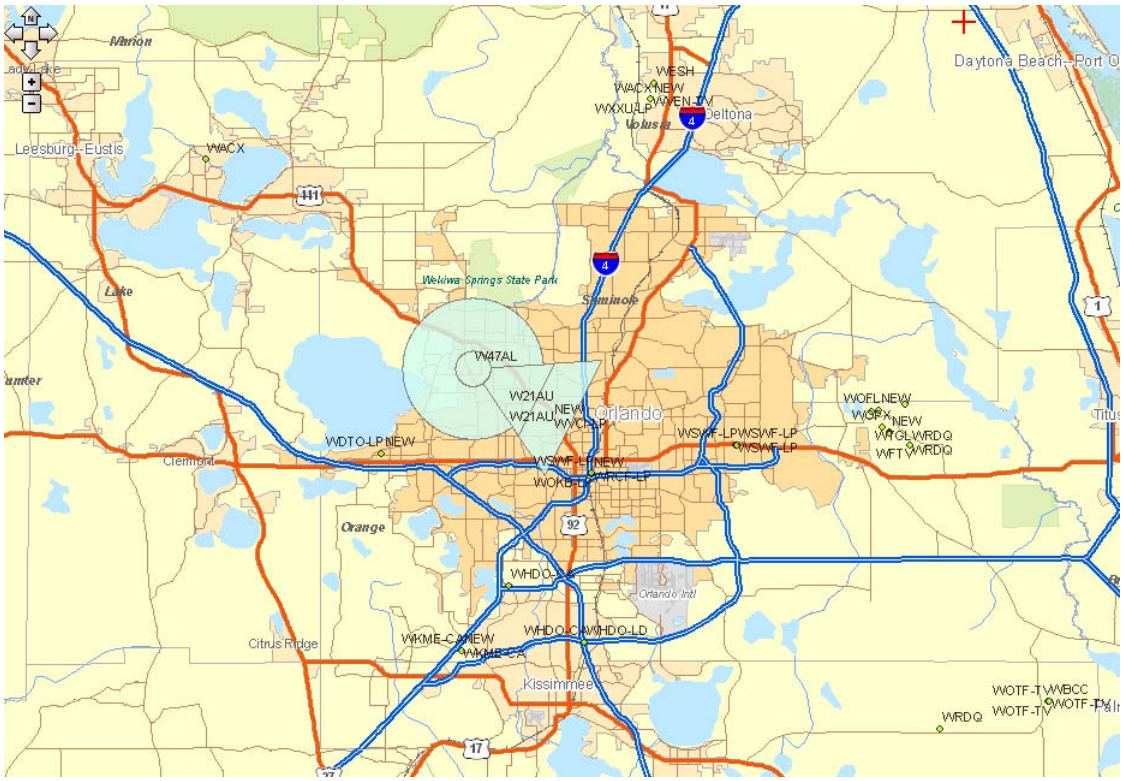
TV BAS (Broadcast Auxiliary Stations) stations include TV pickup stations, TV studio-transmitter-link stations, TV relay stations, TV translator relay stations, TV broadcast licensees, and TV microwave booster stations. See 47 C.F.R. § 74.601.

BAS links are defined in ULS with Radio Service codes as follows:

TP	TV pickup stations
TS	TV relay stations
TI	TV relay stations
TT	TV translator relay stations
TB	TV microwave booster stations



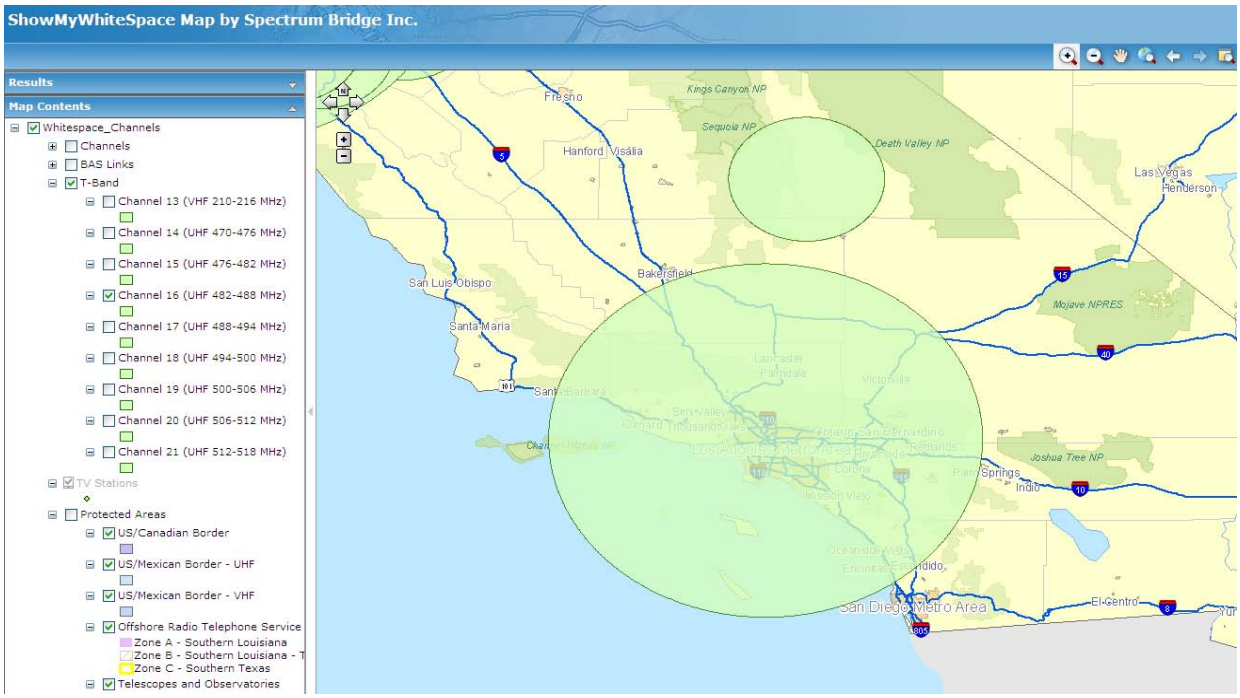
A www.showmywhitespace.com screenshot of a BAS service located northeast of Orlando, FL is shown for reference.



T-Band Metropolitan Areas and Authorized Users

PLMRS/CMRS operates on channels in the range of 14-20 ('T-band') in 13 metropolitan areas, as authorized by 90.303. The communications systems deployed on these channels are principally used in support of public safety operations. In addition, a number of PLMRS/CMRS operations have been authorized under waivers at locations beyond the 130 kilometer protection zones around the 13 metropolitan areas where they are permitted to operate. SBI uses ULS data and GIS tools to derive the required contour sets and exclusion zones necessary to protect these operations.

This www.showmywhitespace.com screenshot shows the exclusion zones for CH 14 in the greater Los Angeles area, including an exclusion zoned required to protect operations granted under a waiver.



WSDs are not permitted to operate within 134 km (co channel) and 131 km (adjacent channel) in the channels and areas specified below:

City	Lat.(N)	Long.(W)	Co-Chan	Adjacent Chan
Boston, MA	42-21-24.4	71-03-23.2	14, 16	13, 15, 17
Chicago, IL	41-52-28.1	87-38-22.2	14, 15	13, 16
Cleveland, OH	41-29-51.2	81-49-49.5	14, 15	13, 16
Dallas/Fort Worth, TX	32-47-09.5	96-47-38.0	16	15, 17
Detroit, MI	42-19-48.1	83-02-56.7	15, 16	14, 17
Houston, TX	29-45-26.8	95-21-37.8	17	16, 18
Los Angeles, CA	34-03-15.0	118-14-31.3	14, 16, 20	13, 15, 17, 19, 21
Miami, FL	25-46-38.4	80-11-31.2	14	13, 15
New York, NY/NE NJ	40-45-06.4	73-59-37.5	14, 15, 16	13, 17
Philadelphia, PA	39-56-58.4	75-09-19.6	19, 20	18, 21
Pittsburgh, PA	40-26-19.2	79-59-59.2	14, 18	13, 15, 17,19
San Fran/Oakland, CA	37-46-38.7	122-24-43.9	16, 17	15, 18
Washington, DC/MD/VA	38-53-51.4	77-00-31.9	17, 18	16, 19

Note that currently, only 11 of the above markets have active PLMRS/CMRS operations.

PLMRS/CMRS operations operating under waivers outside of the 13 metro protection areas will also be protected. WSDs may operate no closer than 54 kilometers from a base station operating under a waiver, and adjacent channel unlicensed WSDs may operate no closer than 51 kilometers from a base station operating under a waiver.

Offshore Radiotelephone Service

The Offshore Radiotelephone Service will be protected from unlicensed WSDs. The WSDB includes contours that precludes all WSDs from operating on channels 15-18 within the designated geographic areas defined below:

Zone A—Southern Louisiana. The geographical area in Zone A is bounded as follows:

From longitude W.87°45′ on the East to longitude W.94°00′ on the West and from the 4.8 kilometer (3 mile) limit along the Gulf of Mexico shoreline on the North to the limit of the Outer Continental Shelf on the South.

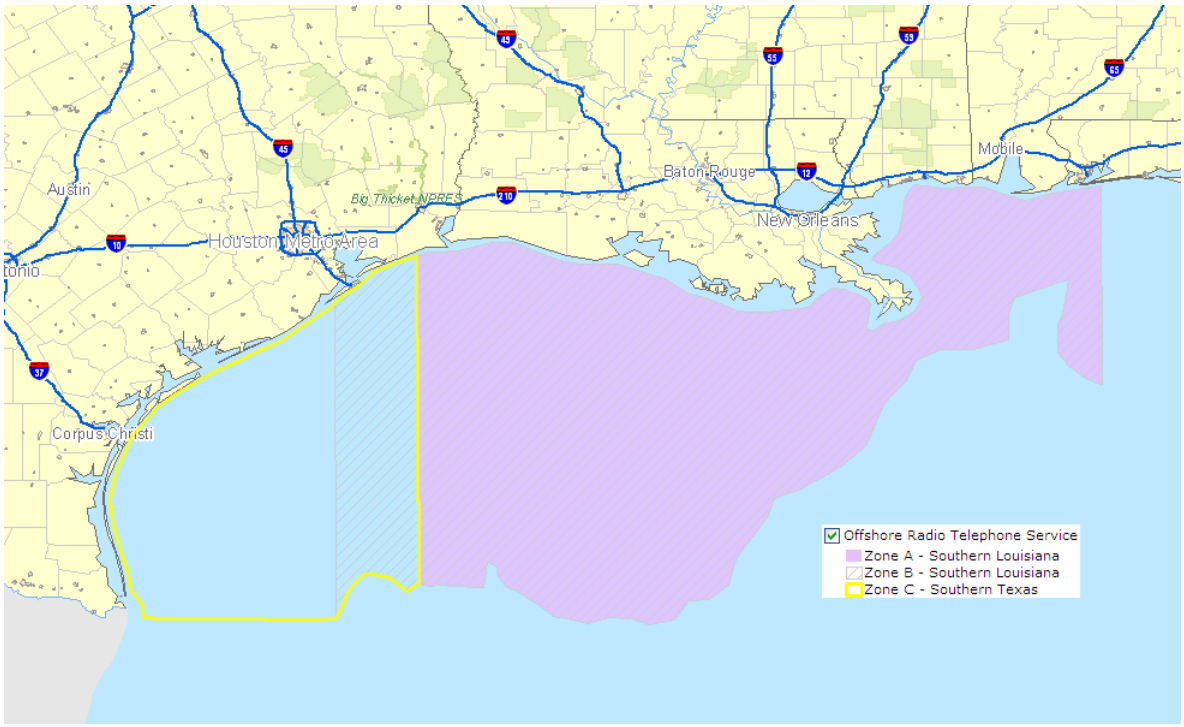
Zone B—Southern Louisiana— Texas. (1) The geographical area in Zone B is bounded as follows:

From longitude W.87°45′ on the East to longitude W.95°00′ on the West and from the 4.8 kilometer (3 mile) limit along the Gulf of Mexico shoreline on the North to the limit of the Outer Continental Shelf on the South.

Zone C—Southern Texas. The geographical area in Zone C is bounded as follows:

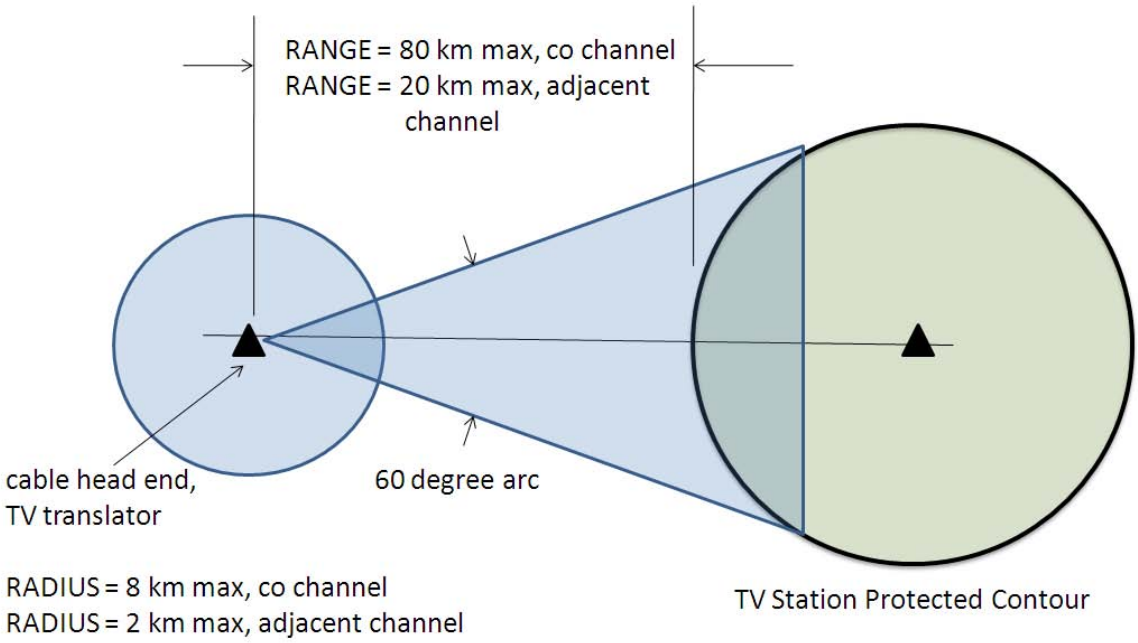
Longitude W.94°00′ on the East, the 4.8 kilometer (3 mile) limit on the North and West, a 282 kilometer (175 mile) radius from the reference point at Linares, N.L., Mexico on the Southwest, latitude N.26°00′ on the South, and the limits of the outer continental shelf on the Southeast.

www.showmywhitespace.com screenshot of the of the Gulf of Mexico and associated Exclusion Zones



Cable Television Headends and TV translator Receive Sites

Cable headends and TV translator sites will be protected from unlicensed WSDs. SBI will allow entities to register these entities online so that they may receive protection when located beyond the existing contours of a parent TV stations. Protection contours are generated in GIS format in using user supplied information, in accordance with the diagram below.

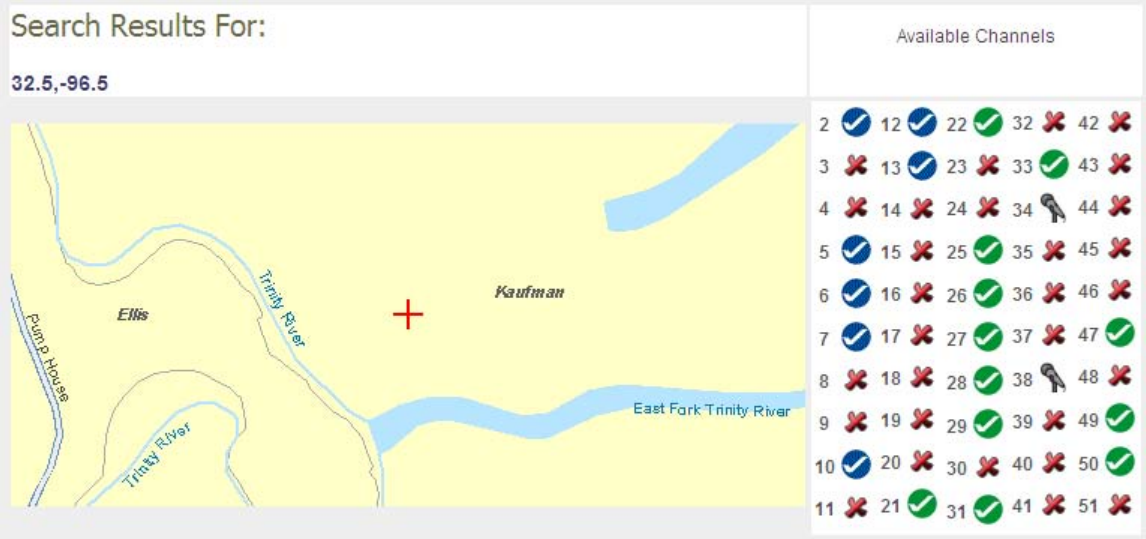


Low Power Auxiliary Services - Wireless microphones and Wireless assist video devices

WSDs will not be permitted to operate within 1 km of the specified coordinates of authorized registered wireless microphone sites during periods of designated use. As authorized wireless microphones are registered, a contour will be generated within the database to protect the designated geographic area and channel.

WSDs will not be permitted to operate on the first available channel on each side of TV channel 37 (608-614 MHz) within 134 km of the 13 metropolitan areas listed in Section 90.303(a). If one or both of those channels is occupied by a licensed service in one or more of these metropolitan areas, operation of WSDs is prohibited on the first channel adjacent to the occupied channel(s). In the example below, a query is performed for a location in Dallas, TX. The first available channels above/below CH 37 are 34 and 38, and they are thus reserved for wireless microphone use and not available for WSDs.

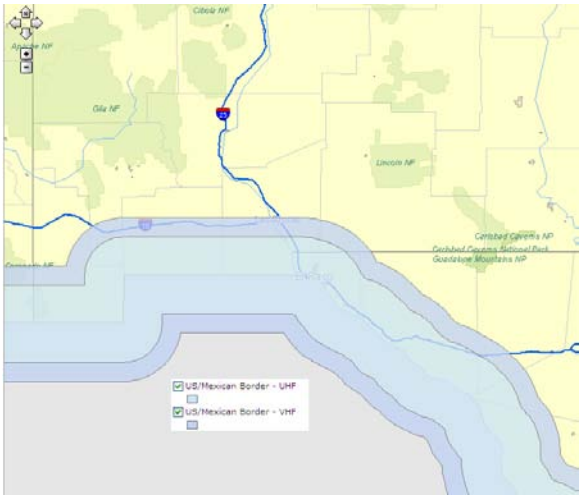
www.showmywhitespace.com screenshot for Dallas, TX with Wireless Microphone exclusion

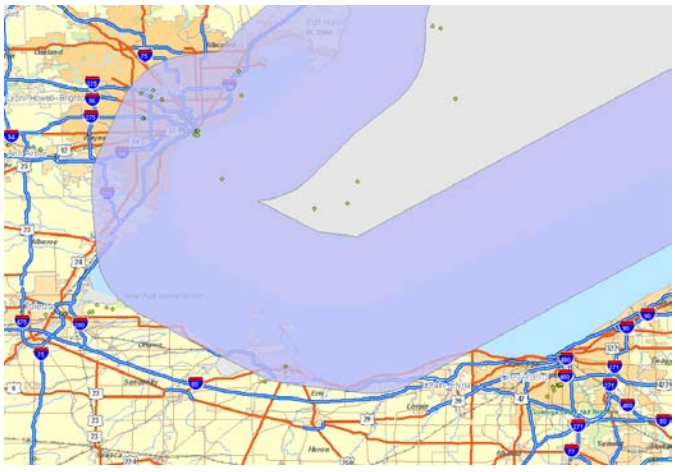


SBI is readily able to support other changes to authorized wireless microphone protection rules, including more frequent database update rates (than the currently specified 24-hour cycle).

International Border Areas

The Canadian and Mexican border areas will be protected from unlicensed WSDs until more detailed agreements are reached with those countries. The WSDB includes buffer areas used to preclude the operation of WSDs to operate on any channels within 32 kilometers of the Canadian border, within 40 kilometers of the Mexican border on UHF channels, or within 60 kilometers of the Mexican border on VHF channels.



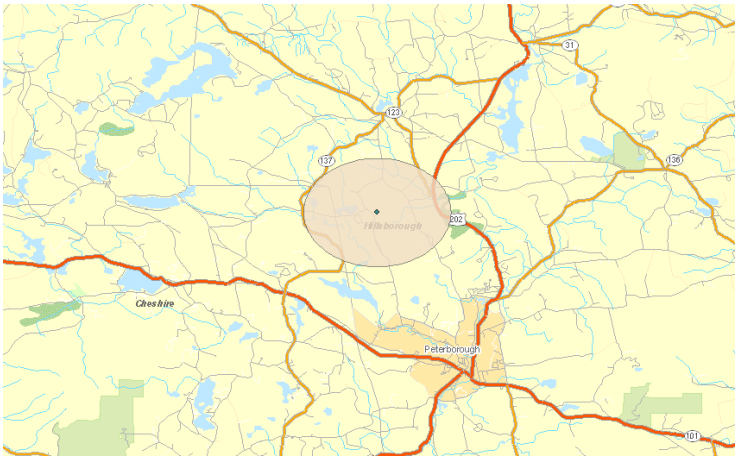


www.showmywhitespace.com screenshots of the Mexican Border near El Paso, TX and the Canadian Border near Chicago, IL

Other Protected Areas

Certain radio astronomy operations and the Table Mountain Radio Receiving Zone will be protected from unlicensed WSDs on all channels. The WSDB will include contours defined in accordance with the following table, to ensure compliance.

Protected Entity	Coordinates (DMS)	Protected Area
Allen Telescope Array	40 49 01 N, 121 28 12 W	2.4 km radius
Arecibo Observatory	18 20 46 N, 66 45 11 W	2.4 km radius
Green Bank Telescope	38 25 59 N, 79 50 24 W	2.4 km radius
Green Bank Telescope	38 26 09 N, 79 49 42 W	2.4 km radius
Very Large Array (VLA)	34 04 43 N, 107 37 05 W	2.4 km radius
Very Long Baseline Array (VLBA) stations (see below)		2.4 km radius
Mauna Kea, Hawaii	19 48 04.97 N, 155 27 19.81 W	
Brewster, Washington	48 07 52.42 N, 119 40 59.80 W	
Owens Valley, California	37 13 53.95 N, 118 16 37.37 W	
Kitt Peak, Arizona	31 57 22.70 N, 111 36 44.72 W	
Pie Town, New Mexico	34 18 03.61 N, 108 07 09.06 W	
Los Alamos, New Mexico	35 46 30.45 N, 106 14 44.15 W	
Fort Davis, Texas	30 38 06.11 N, 103 56 41.34 W	
North Liberty, Iowa	41 46 17.13 N, 91 34 26.88 W	
Hancock, New Hampshire	42 56 00.99 N, 71 59 11.69 W	
St. Croix, United States VI	17 45 23.68 N, 64 35 01.07 W	
Naval Radio Research Obs.	38 31 02 N, 79 16 42 W	2.4 km radius
Table Mountain Rec. Zone	40 07 50 N, 105 14 40 W	2.4 km radius



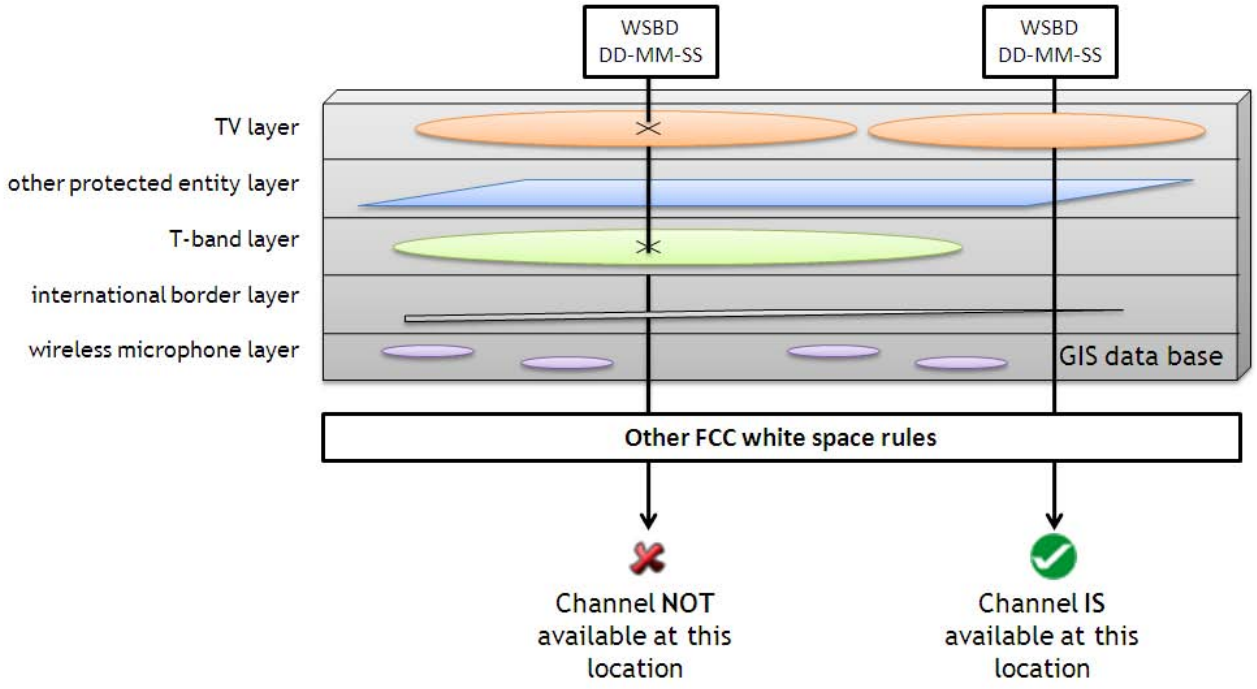
www.showmywhitespace.com screenshot of a Protected Entity in Hancock, NH

Appendix 2: Channel Availability and Determinations

The Channel Allocation engine is used to determine white space allocations available to WSDs in accordance with the FCC's white space rules and by comparing the supplied location of a WSD device (in NAD-83/WGS-84 DDMMSS format). This is accomplished using GIS shapefiles stored in the GIS data repository. More specifically, each request by a WSD is processed by determining the intersection of protected entity shapefiles with the WSD location. From these results, a channel availability solution is generated (as a function of WSD mode and antenna height) and provided to the WSD. All geographic coordinates will be referenced to the North American Datum of 1983 (NAD 83), which is very similar to WGS-84 coordinates provided by commercial GPS equipment.

Channel Selection

The diagram below illustrates the process used to determine channel availability. The first step is comparing the WSD location with the locations of protected entities. The second step in the process requires the application of general regulatory policy (non-geographic), e.g. fixed devices may operate on any channel between 2 and 51, except channels 3, 4 and 37 and operation of WSDs is prohibited on the first available channel on each side of TV channel 37 in 13 metropolitan areas listed Section 90.303(a).



After the available channels are determined for a specific WSD and location, the channel information is assembled into a defined packet format and forwarded to the respective WSD per the protocols defined in the response. All interface protocols are open and non-proprietary.

Fixed WSDs will access the database at least once a day (under the current rules) to verify that the operating channels continue to remain available. A Mode II personal/portable device will access the database for a list of available channels each time it is activated from a power-off condition and re-check its location and the database for available channels if it changes location during operation. A Mode II personal/portable device that has been in a powered state will recheck its location and access the database daily to verify that the operating channel(s) continue to be available.

The definition of power state of the device and the mobility determination of the device are outside the scope of the database operations. The proposed solution can service WSDs significantly more regularly than once every 24 hours, so periodic requests from devices that change location or power state are fully factored into the design.

Channel Revocation

Although the FCC has not declared a requirement for the timely revocation of a channel (before the channel map expiration time), the means to accomplish this exists. WSDs will access the database at least once a day to verify channels continue to be available. If, in between these queries, a wireless microphone is registered within 1 km of the known location of a white space device, a message maybe forwarded to the WSD with an updated channel map.

Potential Sources of Error

Per the report and order *"the geographic coordinates of a fixed WSD or a Mode II personal/portable device shall be determined to an accuracy of +/- 50 meters by either an incorporated geo-location capability or a professional installer"*. This is well within the accuracy of generally available, imbedded GPS technology. Therefore it is important that all calculations, conversions and processes produce results well within this range of accuracy, preferably within an order of magnitude. All GIS elements are stored and manipulated using DD.DDDDDD format, (8 significant figures) which yields ~11 cm resolution. This resolution is an order of magnitude (and in many cases several orders of magnitude) more precise than even the highest resolution protected entity data. Fundamentally, any errors introduced into geo-location conversions or calculations are considered insignificant with respect to WSD location accuracy.

One source of discrepancy in derived data may be in the conversion of contour data provided by the FCC into GIS shapefiles. If the TV contours, as defined by the FCC, are de facto 'unsmoothed', 360 sided polygons, this is not an issue. However, if one considers a contour to be a smooth figure as defined by an algorithm yielding many more points, some small difference may exist. These differences are virtually insignificant and should be considered irrelevant when compared to the accuracy of the propagation (e.g., R-6602) model itself. More specifically, the worst case difference in range between the contour of a 360 sided polygon and a smoothed

(circular) shape is ~38 ppm, or 16 feet at a range of 80 miles. When the difference in areas is calculated, the difference is 501 ppm, or 1.81 acres at a range of 80 miles in a 1 degree sector. Although the errors would be greater when irregularly shaped polygons are considered, they are still relatively small and insignificant when compared to the accuracy of GPS technology and propagation models.

Format:	Approximate Resolution:
DD.DDDDDD	11 cm
DD.DDDDD	1.1 m
DD-MM-SS.S	3 m
DD-MM-SS	30 m

Appendix 3: Authorized Protected Entity Registration and Security

Online User interface and Registration Process

Presently the System uses Software as a Service (SaaS) design principles to deliver features to users requesting to register for protected entity status. This means no software needs to be installed on a user's communications device. SBI will modify this solution to meet the final FCC requirements.

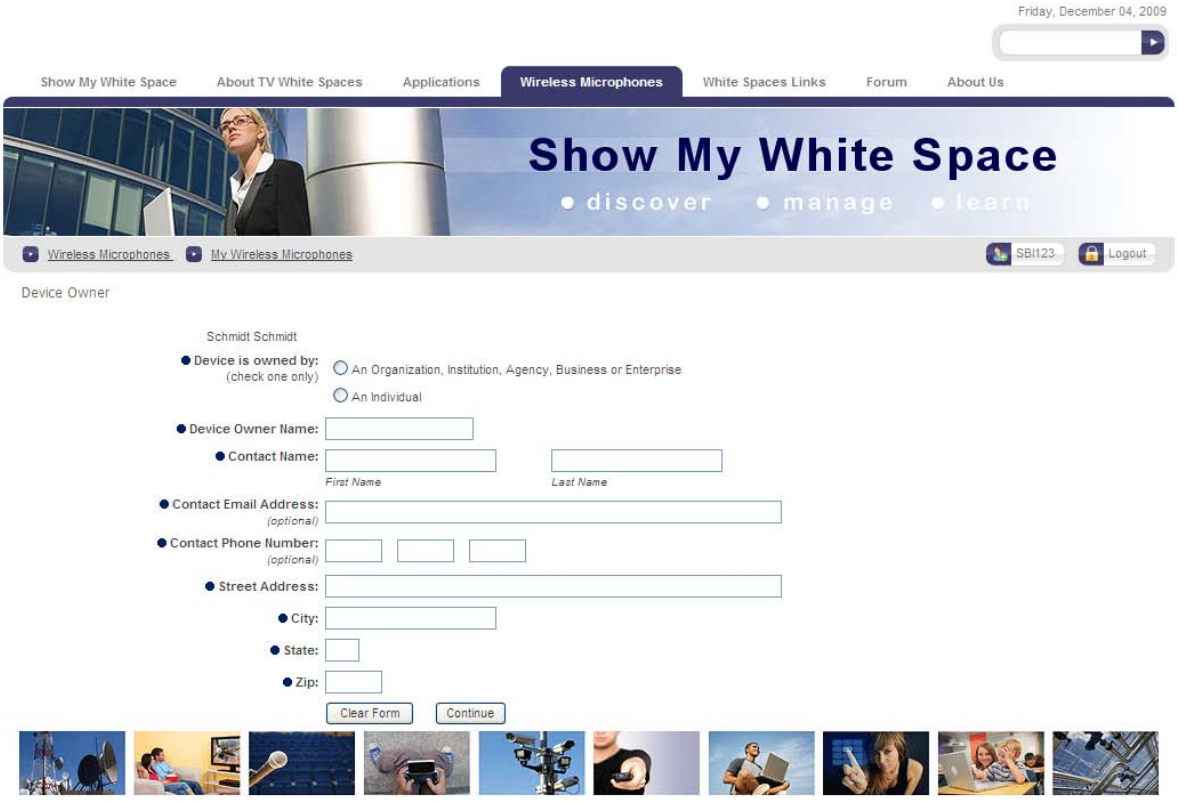
All software is accessed via a web browser, and unless publicly available data (i.e., FCC License data) is accessed, all software and data is guarded by security requiring a username and password. Using the SaaS approach gives Spectrum Bridge the ability to effectively implement new releases and patches on an as needed basis. Security updates are ensured for all users as technology and the market dictate. Transactions will be securely logged to ensure that an adequate audit trail is available to resolve any subsequent issues.

The solution provides a web based portal for the registration (or update) of authorized protected entity information (BAS links, cable headends, wireless microphones and TV translators). This interface will provide a secure interface for registering entities not provisioned within existing regulatory databases. The required registration information collected will be shared with other WSDBs and designated data repositories.

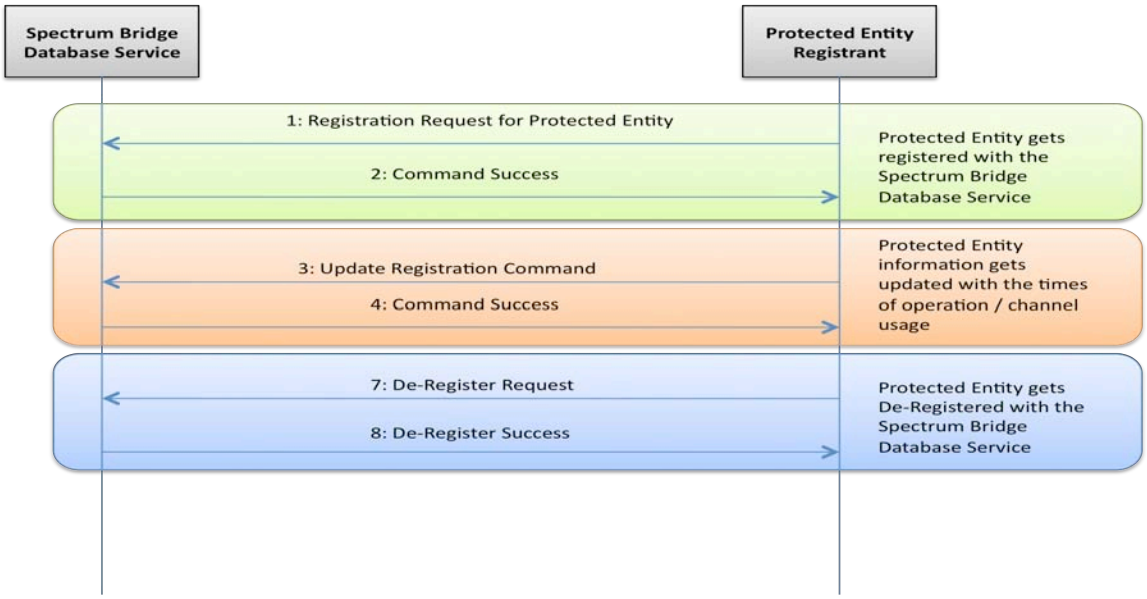
In order to access the online services a user must first register. Mail back credentials procedures will be used to validate the user and the registration data will be securely stored in a manner that it can be made available to the FCC in the case of a dispute over the validity or accuracy of a channel reservation request.

An example of the device/channel reservation screen is shown below. This screen is only available to a registered user.

The public interface to www.showmywhitespace.com will show the existence of all protected entities registered via this interface but will not provide private data (such as user name and contact information).



Protocol – authorized Protected Entity Registration



Online Registration of authorized Protected Entities

The Registrant must register via a GUI interface (https) with the Database using a user selectable user-ID, password, contact email, contact address and a valid FRN. Once these credentials are validated with the Databases Certificate Authority a unique Registrant ID will be assigned to the Registrant. Credentials will then be embedded into a standard X.508 certificate. Registrant may then begin using the certificate provisioned to it with the credentials for further communication with the Database. Message flow is as follows.